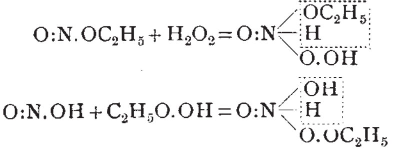
RESEARCHES ON ORGANIC PEROXIDES.

IN the latest number of the *Berichte*, v. Baeyer and Villiger have a number of interesting communications. The preparation of ethyl hydrogen peroxide, $C_2H_5O.OH$ is described. It is obtained by treating diethylsulphate with a solution of hydrogen peroxide in alkaline solution. The liquid is then acidified and distilled, when the new compound passes over between 90° and 100° mixed with alcohol and water. By further treatment a solution may be obtained boiling at 47–49° at 100 mm. and containing 80 per cent. of the peroxide. At the ordinary pressure it boils about 95°. It is soluble in water, alcohol and ether. It has a smell of both bleaching powder and acetaldehyde. A drop on the skin produces inflammation. It is relatively stable and may be kept for many weeks with very slight alteration. By superheating the vapour in a test-tube, a moderate detonation occurs. Dropped on finely divided silver it decomposes with a sharp explosion. It is a weak acid of about the strength of a phenol and gives salts with alkalis and alkaline earths. It is a strong oxidising agent. In studying the action of ethyl hydrogen peroxide with different reagents, the authors find that whereas nitrous acid yields nitric acid with hydrogen peroxide, alkyl nitrites do not give alkyl nitrates, but nitric acid and alcohol. On the other hand, ethyl hydrogen peroxide and nitrous acid or ethyl hydrogen peroxides and alkyl nitrites give in both cases the alkyl nitrate. These reactions are explained on the assumption that an additive compound is first formed from which either water or alcohol is subsequently removed. Moreover, where there is a choice between the removal of an "alkoxyl" or "hydroxyl" group, the latter takes precedence. This alone would not explain the behaviour of ethyl nitrite and hydrogen peroxide, on the one hand, and nitrous acid and ethyl hydrogen peroxide on the other, which should yield the same product, viz., ethyl nitrate.

$$O{:}N.OC_2H_5 + H_2O_2 = O{:}N(OH)_2OC_2H_5 = O_2N.OC_2H_5 + H_2O$$

$$\begin{aligned} O{:}N.OH + C_2H_5O.OH &= O{:}N(OH)_2OC_2H_5 \\ &= O_2N.OC_2H_5 + H_2O. \end{aligned}$$

But if the peroxides form additive compounds by separation into H and O_2H or $O_2C_2H_5$ ions, the apparently anomalous changes are readily explained.



$$O{:}N.OC_2H_5 + H_2O_2 = O{:}N\begin{cases} OC_2H_5 \\ H \\ O.OH \end{cases}$$

$$O{:}N.OH + C_2H_5O.OH = O{:}N\begin{cases} OH \\ H \\ O.OC_2H_5 \end{cases}$$

The nitrosoperoxide acid then by intramolecular rearrangement passes into nitric acid or its ester.

In the same journal, v. Baeyer and Villiger describe a hydrate of sulphurylchoride, $SO_2Cl_2 + 15H_2O$, which they prepare by pouring the acid chloride on ice. The hydrate has the appearance of camphor and remains undecomposed by ice-cold water for hours at a time.

The disputed question as to whether hydrogen peroxide and silver oxide, when brought into contact, yield the oxygen of the metallic oxide as well as an atom of oxygen of the peroxide, which is Thénard's view, or whether, according to Berthelot, the silver oxide acts as a catalysator by reducing the peroxide of hydrogen to water, is determined by v. Baeyer and Villiger in favour of Thénard.

IRON AND STEEL INSTITUTE.

THE annual general meeting of the Iron and Steel Institute was held on May 8 and 9. Sir William Roberts-Austen, K.C.B., the retiring president, announced that Andrew Carnegie Research Scholarships, each of the value of 100*l.*, had been awarded to Dr. A. Stansfield (London), to Dr. J. A. Mathews (New York) and to Mr. J. Goldberg (Leoben, Austria). Mr. Carnegie announced his intention of doubling his original donation for the purpose of founding these scholarships. Mr. William Whitwell was then inducted into the presidential chair. Having presented the Bessemer Gold Medal for 1901 to Mr. John Edward Stead, in recognition of the value of his investigations of the physical and chemical properties of iron and steel, the president delivered his inaugural address, in which he reviewed the scientific and industrial achievements of the past reign, and enumerated some of the most important problems in metallurgy that still await solution. A vote of thanks to the president for his admirable address was proposed by Mr. Carnegie and seconded by Sir Lowthian Bell.

The first paper read was by Mr. A. Greiner, of Seraing, Belgium, on dust in blast-furnace gases, in which he described the methods adopted to get rid of the dust in blast-furnace gases used as motive power for blowing-engines.

Mr. J. E. Stead then described some clearly defined idiomorphic crystals recently discovered in the hearth of a blast furnace at Blaina, Monmouthshire. They were found in a cavity of the sandstone foundation of a furnace, in which spiegeleisen and ferromanganese had been made. The crystals yielded on analysis: manganese, 51·75; iron, 35·76; silicon, 3·62; carbon, 3·71; oxygen, &c., 5·16. They belong to the orthorhombic system, and the results of measurements by Mr. H. Bauerman and by Mr. L. J. Spencer are given in the paper. The compound is described as a carbo-silicide of manganese and iron.

Mr. J. E. Stead and Mr. John Evans next read an important paper on the influence of copper on steel rails and plates. It is generally thought that copper has a very deleterious effect, and engineers, when buying steel, frequently specify that it must be absent. The authors clearly show, however, that the general opinion is erroneous. They prove that between 0·5 and 1·3 per cent. copper has no deleterious effect on either the hot or cold property of steel; that a very large amount (2 per cent.) makes the steel more liable to be over-heated; and that in small quantities it slightly raises the tenacity and the elastic limit, but, unlike phosphorus, does not sensibly make the steel liable to fracture under sudden shock. Like carbon, it reduces the power of the steel to extend under stress, but this is not pronounced when the quantity is small. The effect is more marked when large quantities are present. Lastly they prove that if the evidence of the open-hearth steel trial can be confirmed, copper, instead of producing redshortness, has the contrary effect of changing redshort steel into steel which will roll without cracking.

Mr. William Garrett, of Cleveland, Ohio, submitted a comparison between American and British rolling-mill practice. The paper was followed by an animated discussion, which was resumed on Thursday.

Mr. R. M. Daelen (Düsseldorf) described some recent developments of the use of hydraulic power in the manufacture of iron and steel.

Mr. Axel Sahlin discussed the economic significance of a high percentage of silicon in pig iron for the acid steel processes. The demand for high silicon in pig iron is, he considers, doing much to hamper progress in a certain branch of the British iron industry.

The paper by Prof. J. O. Arnold on the properties of steel castings embodied research work extending over six years. The lessons taught by the data set forth in the preliminary experiments detailed in this paper show that pure iron and carbon steel is not a suitable material for fulfilling the modern specifications drafted by engineers for steel castings. With iron and carbon castings the ductility demanded can be ensured with ease, but with such ductility it is impossible to correlate the required tenacity. The latter property, it is true, can be obtained from iron and carbon castings, but at the expense of an almost complete loss of ductility. Therefore, as has already been remarked, excepting the nearly pure iron the series of castings described have small manufacturing interests. Nevertheless they form the basis upon which the mechanical influence of silicon and manganese can alone be scientifically measured.

The remaining papers were taken as read. Among these the paper by Mr. Axel Wahlberg, of Stockholm, on Brinell's method of determining hardness and other properties of iron and steel was an elaborate memoir of great importance. The method consists in forcing, by means of pressure, a hardened steel ball into the material to be tested so as to cause an impression, the diameter of which is then to be measured, in order to obtain the spherical area of the concavity. The quotient resulting from dividing the maximum pressure by this area will then represent what is called by Brinell a *hardness number*, indicating, according to him, the amount of pressure (kilograms per square millimetre) to which the material so tested has been subjected. With this method a number of researches have been carried out, detailed particulars of which were given. They relate to the determination of hardness of various metals, to

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controlling forging tests, and to the hardening of iron and steel. Under the last head experiments were made to ascertain the influence of the percentage of carbon on the hardening capacity, the hardening effect of different quenching liquids, the influence of the temperature of the quenching liquid on the hardening result, the influence of different hardening temperatures. Other researches described dealt with an attempt to ascertain the homogeneity of iron and steel, the degree of annealing, the influence of cold-working, determination of the yield point, ultimate stress and elongation, and tests of blanks for gun barrels.

Prof. E. D. Campbell gave the results obtained at the University of Michigan during the past three years in investigating the heat of formation of the compounds of iron with carbon and silicon.

Mr. Axel Sahlin described a water-cooling device introduced by himself for protecting the walls of the lower part of the blast furnace.

Mr. J. M. While submitted a description of the new Bessemer shop and heating pits at the Barrow Hæmatite Steel Company's works. The results obtained are of interest as showing that the faster working in vogue in the United States cannot be introduced into England with advantage, for the same conditions do not apply in each country.

Mr. H. E. Wimperis, acting on a suggestion from Prof. Ewing, measured Young's modulus for a long rod by tension in an ordinary testing machine, and compared the value thus obtained with that found by experiments on pure bending. The two values differ slightly from each other, but such differences as are found may be regarded as indicating that there is no internal sliding due to layers of any impurity that may be contained in the metal.

Mr. Bennett H. Brough, the secretary, described a medal presented to the Institute by Mr. E. J. Ljungberg. It was struck in steel from the Domnarfvet Steelworks, Sweden, and is the first medal that has ever been struck in that metal. The soft basic Bessemer steel of which the medal is made contained: carbon, 0·05; manganese, 0·19; silicon, 0·007; phosphorus, 0·002; sulphur, 0·005.

Baron H. von Jüptner submitted a paper on iron and steel from the point of view of the phase-doctrine, in which he controverted some of the views elicited by the publication of the paper by Bakhuis-Roozeboom last autumn. He deals chiefly with the state of equilibrium between martensite and graphite.

The next meeting of the Institute will be held in Glasgow in September.

VITRIFIED QUARTZ.[1]

ALTHOUGH the great improvements introduced into the art of glass making by Abbe and Schott have led to marked advances in microscopy, in thermometry and in other departments during the last quarter of a century, glass is still unsuitable for many of the purposes to which we put it, and there remains a real need for some plastic material more infusible, more insoluble, more fully transparent, more elastic and more stable under changes of temperature than glass.

Such a substance exists in the form of vitrified quartz, or vitrified silica as I shall prefer to call it. Vitrified silica was first made in 1839 (*Comptes rendus*, viii. 678, 711) by M. Gaudin, who spun threads of it by hand and noticed their flexibility; and made small, very hard pellets of it by dropping fused quartz into cold water, and observed that in this form it was inactive to polarised light.[2] It was rediscovered in 1869 by M. Gautier (*Comptes rendus*, cxxx. 816), who made capillary tubes and spirals of vitreous silica and exhibited them at the Paris Exhibition in 1878, but who failed to obtain larger objects even with the aid of the electric furnace. Finally it was discovered yet once again, in 1889, by Prof. C. V. Boys, who used the torsion of "quartz fibres" for measuring small forces and produced fine tubes and small bulbs of the same material, and who was the first to fully recognise the great value of this remarkable substance.

As all who are here to-night are not chemists, I may remind you that quartz or rock crystal has for some time past been used by spectacle makers and in the construction of optical instruments; and that it is a form of oxide of silicon[1] which is very familiar to us all in the forms of sand and flint. Quartz is occasionally found in magnificent masses, but our chief source of supply is Brazil, where it occurs in large fragments like those before us on the table.

Quartz itself exhibits many of the desirable qualities enumerated above. It is hard, transparent to the ultra-violet rays, difficult to melt, a good insulator, and insoluble in most solvents, but it bears sudden changes of temperature very badly, and therefore it is not easy to manipulate quartz at high temperatures. When it has been vitrified by heat, however, it becomes much more tractable, and in the vitrified state (vitrified silica) it is not very difficult to deal with.

It is about this "vitrified silica," how to prepare it and fashion it into apparatus when plastic, and about its properties and uses that I am about to address you to-night.

The first obstacle met by those who wish to obtain vitrified silica is caused by the tendency of quartz to splinter. It will not bear contact with a flame. As you see, when a piece of quartz is thrust into a flame it cracks and falls to pieces, and the fragments again break up when similarly treated. Consequently, it was very difficult for the pioneer workers to soften their quartz in the flame. It is true that if the quartz be broken small and heated to redness in a crucible it becomes more easy to manage, but even then it gives trouble, and I should not like to say how much my first silica tube, which held about 5 c.c., had cost me for oxygen and labour when it was finished.

Fortunately we have found that we can prevent the splintering of quartz by heating it in small fragments to about 1000° C. and throwing it quickly into cold water. As you see, when this is done the quartz becomes white and enamel like, and after the treatment has been repeated the product, though still in masses, will not splinter to the slightest extent if it be thrust suddenly into the hottest part of an oxy-hydrogen flame. The preparation of this non-splintering silica constitutes the first stage of the process we are about to show you.

Another difficulty is connected with the oxy-gas burner. Vitrified silica only becomes sufficiently plastic for our purpose when it is above the melting point of platinum; and it cannot be heated sufficiently in all parts of an oxy-gas flame. What is wanted is not so much a very large flame as one which presents a very hot spot (this is situated just beyond the inner blue cone of the flame). After trying all sorts of burners I have concluded that the "mixed gas" jets give the best results, and of the burners I have tried the injector burner of Mr. Jackson, of Manchester, is decidedly the best I have met with.

The first step in the process of converting the white enamel like non-splintering silica into tubes and other vessels consists in pressing together the ends of two small fragments of the solid held in platinum forceps till they adhere, adding a third lump, then a fourth, and so on until a rough rod has been made. This rod is afterwards reheated and drawn out into finer rods about 1 mm. in diameter. In doing this care must be taken to heat each fresh mass of material slowly and from below upward in order that there may be as few bubbles as possible in the product.

A few of the fine rods of silica are next bound round a stout platinum wire, or twisted into a spiral while soft (Boys' and Dufour's method), and heated in the flame till their sides adhere. The uncouth tube thus produced is reheated, drawn out and closed at one end, a bulb is blown on the closed end in the usual manner, and this, when again drawn out, gives us a fine and fairly regular tube which can be lengthened by adding silica to one end of it, blowing a new bulb from this and drawing it out as before.

The enlargement of the small bulbs was rather difficult at first. My earliest attempts consisted in adding small lumps of silica to one end of a bulb, softening them in the flame and expanding the bulb by blowing. It is not impossible to succeed in this way, though the vessels so produced are apt to be uncouth in appearance. But the process is unsatisfactory owing to the fact that often the thinner parts of a bulb immediately surrounding the mass to be expanded become hotter and softer than the latter. When this happens the bulb bursts, and as it can only be repaired by the addition of fresh lumps of silica the process is apt to be tedious and expensive. After many failures, it occurred to me that I might develop the bulbs by applying thin rings of silica as shown in Fig. 1, heating them until the silica begins to spread

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[1] A discourse delivered at the Royal Institution, on March 8, by W. A. Shenstone, F.R.S.

[2] A recent observation made by Prof. S. P. Thompson confirms this.

[1] Silicon was discovered by Berzelius in 1823.

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